Intercondylar distance before and after mandible resection

Kruse, A l ; Lecci, N L ; Grätz, K W ; Lanzer, M ; Gander, T ; Lübbers, H-T

Abstract: PURPOSE: One of the goals of mandible resection and reconstruction is achieving optimal occlusion. Therefore, the aim of the present study was to evaluate the pre- and post-operative condyle distances. PATIENTS AND METHODS: All computed tomography (CT) scans of 32 patients with a partial mandible resection who were treated between 2006 and 2011 were evaluated retrospectively. The distances between the condyle centres were measured before and after mandible resection. RESULTS: The preoperative intercondylar distance of the 32 patients was between 85.8 and 109.5 mm (median = 100.5 mm), and the post-operative distance was between 87.0 and 110.5 mm (median = 100.6 mm). There was no significant difference between pre- and post-operative distances. CONCLUSION: Reconstruction plates and bony reconstructions do not significantly change the intercondylar distance.

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Abstract

Purpose

One of the goals of mandible resection and reconstruction is achieving optimal occlusion. Therefore, the aim of the present study was to evaluate the pre- and post-operative condyle distances.

Patients and methods

All computed tomography (CT) scans of 32 patients with a partial mandible resection who were treated between 2006 and 2011 were evaluated retrospectively. The distances between the condyle centres were measured before and after mandible resection.

Results

The preoperative intercondylar distance of the 32 patients was between 85.8 and 109.5 mm (median = 100.5 mm), and the post-operative distance was between 87.0 and 110.5 mm (median = 100.6 mm). There was no significant difference between pre- and post-operative distances.

Conclusion

Reconstruction plates and bony reconstructions do not significantly change the intercondylar distance.

Introduction

Mandible resection is a common surgical procedure performed as a result of different indications such as malignant tumours or osteomyelitis. Reconstruction of the mandible is routinely performed by either bone reconstruction or load-bearing osteosynthesis. For bone reconstruction of the mandible, fibula, deep circumflex iliac artery and scapula flap are often used, and they together represent a success rate of >90%[1]. They can be used for primary or secondary bone reconstruction. In the long-term, only reconstruction plates lead to complications such as fractures or exposure of plates[2,3].

The basic goals of any technique are to maintain the preoperative occlusion, sufficiently support the soft tissues to achieve a symmetric appearance of the face and correctly position the condylar process for functional reasons. Consequently, inadequate reconstruction techniques can lead to disturbances of occlusion and condyle position as well as unfavourable aesthetic results. All these problems are quite difficult to address in secondary correction, and therefore, early detection of inadequate reconstruction is necessary.

To our knowledge, no study has been performed so far dealing with the determination of pre- and post-surgical intercondylar distance, which we believe could be a promising predictor for adequate reconstruction of the mandible. The aim of the current study was to evaluate the pre- and post-surgical intercondylar distance with regard to primary and secondary bone reconstruction.

Patients and methods

Data were included for patients who were treated for partial resection of the mandible between January 2006 and April 2011 in the Department of Cranio-Maxillofacial Surgery, University Hospital Zürich, Switzerland. Data were analysed retrospectively. Inclusion criteria were partial resection as well as patients with pre- and post-operative computed tomography (CT) scans—either multislice CT (MSCT) or cone-beam CT (CBCT). Exclusion criteria were inadequate information and partial resections without loss of continuity. From a total of 81 patients, 32 were included in this study (Table 1).

Furthermore, it was investigated whether the occlusion pre- and post-surgery changed. Positive occlusion was defined as correct molar region with a minimum of two pairs of antagonists only with the patient's own teeth (i.e. no removable or fixed prostheses).

For measurements, MSCT scans were analysed with an AGFA Study Viewer Version 5.0.1 (Agfa HealthCare NV, Morstel, Belgium) and CBCT scans were analysed with a KaVo Exam Vision Version 1.8.1.10 (KaVo Dental GmbH, Biberachan der Riss, Germany).

Each dataset was orientated according to the Frankfurt horizontal and mid-sagittal planes, and afterwards, measurements were performed in the coronal and axial planes. For each patient and plane, four measure points were selected (the most lateral and most medial points). The two lateral points were combined for determination of the maximal intercondylar distance, and the two medial points were combined for determination of the minimal intercondylar distance (Figures 1 and 2). To minimize any effect of potential intra- and inter-observer variability, the same observer performed all measurements on one single date. The observer was blinded except for that information obvious from the radiographic dataset.

The 32 patients with a total of 42 surgical procedures were divided into two groups: group 1 included patients with primary surgery (21 with reconstruction plate and 11 with bone) and

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Table 1 Patient data regarding age, sex, indication, region of resection and type of reconstruction

Patient	Age (years)	Sex	Diagnosis	Localization	Condyle	Reconstruction
1	43	Male	Tumour	Combination	No	Plate
2	62	Male	Osteomyelitis	Combination	No	Plate
	66	Male	Second surgery	Combination	No	Scull
3	69	Male	Tumour	Combination	No	Plate
4	63	Male	Tumour	Combination	No	Plate
	64	Male	Second surgery	Combination	No	Scull
5	62	Female	Tumour	Posterior	No	Plate
	63	Female	Second surgery	Posterior	No	Scull
6	49	Male	Tumour	Combination	No	Plate
	51	Male	Second surgery	Combination	No	Fibula
7	76	Male	Tumour	Combination	No	Plate
8	67	Female	Tumour	Combination	No	Plate
9	63	Male	Osteomyelitis	Combination	No	Scull
10	69	Male	Tumour	Combination	No	Plate
	70	Male	Second surgery	Combination	No	Scull
11	61	Female	Tumour	Combination	No	Plate
	62	Female	Second surgery	Combination	No	Scull
12	61	Female	Osteomyelitis	Combination	No	Plate
	62	Female	Second surgery	Combination	No	Scull
13	26	Male	Tumour	Posterior	No	Scull
14	45	Male	Tumour	Combination	No	Scull
15	53	Male	Tumour	Combination	No	Plate
	54	Male	Second surgery	Combination	No	Scull
16	69	Male	Tumour	Posterior	Yes	Plate
17	54	Male	Osteomyelitis	Combination	Yes	Fibula
18	73	Male	Tumour	Combination	No	Plate
	74	Male	Second surgery	Combination	No	Scull
19	10	Male	Tumour	Posterior	No	Fibula
20	56	Male	Tumour	Posterior	No	Platte
21	85	Female	Tumour	Combination	No	Platte
22	64	Female	Tumour	Combination	No	Plate
	65	Female	Second surgery	Combination	No	Scull
23	64	Male	Tumour	Posterior	Yes	Plate
24	70	Female	Osteomyelitis	Combination	Yes	Fibula
25	59	Male	Tumour	Posterior	No	Plate
26	58	Male	Tumour	Combination	No	Fibula
27	50	Female	Osteomyelitis	Combination	No	Plate

(Continued)

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Table 1 (Continued)

Patient	Age (years)	Sex	Diagnosis	Localization	Condyle	Reconstruction
28	53	Female	Osteomyelitis	Combination	No	Plate
29	55	Male	Tumour	Combination	No	Fibula
30	59	Female	Tumour	Combination	No	Fibula
31	9	Female	Tumour	Combination	Yes	Fibula
32	46	Male	Osteomyelitis	Combination	No	Fibula

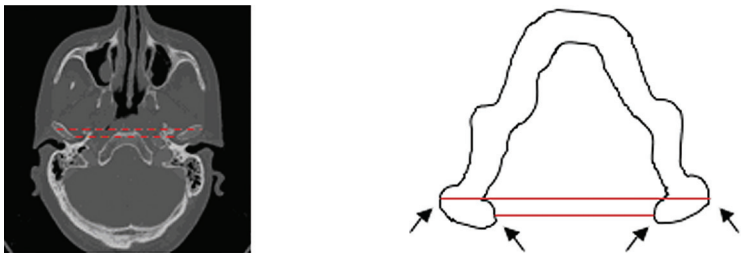

Figure 1: Measurement of intercondylar distance in axial plane.

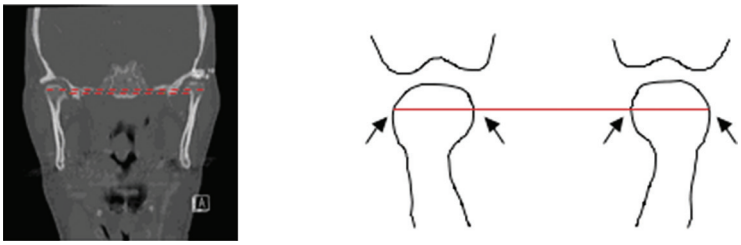

Figure 2: Measurement of intercondylar distance in coronal plane.

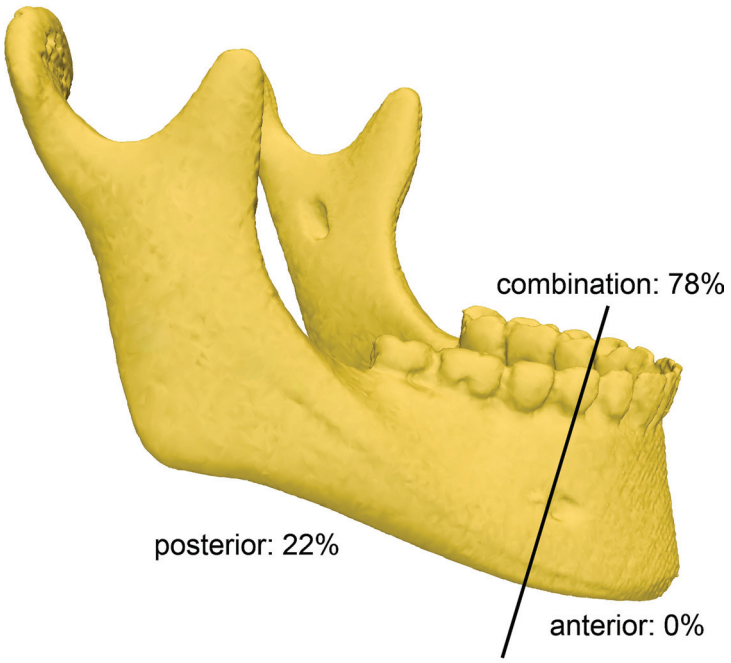

Figure 3: Definition of groups with regard to anatomical location of the resection.

group 2 included patients with secondary reconstruction (10 with bone).

For statistical analysis, SPSS 19 (SPSS Inc., Chicago, IL, USA) was used and $P \leq 0.05$ was considered to be statistically significant.

The study design met the criteria of paragraphs 4a and b of the guidelines (version 21.5.2010) of the Cantonal Ethics Committee of Zürich. Therefore, the design was exempt from institutional review board approval. The study design thereby fulfilled the guidelines of the Declaration of Helsinki concerning ethical principles for medical research involving human subjects.

Results

Of 32 patients, 21 were males and 11 were females. The indications for resection were squamous cell carcinoma (n = 16), ameloblastoma (n = 2), ameloblastic carcinoma (n = 1), osteosarcoma (n = 1), osteodestructive fibrous tumour (n = 1), intraosseous myxoma (n = 1), rhabdomyosarcoma (n = 1), osteoradionecoris (n = 5) and osteomyelitis (n = 4) (Table 1).

The location was divided into three groups: anterior mental foramen (0%), posterior mental foramen (22%) and combination of both (78%) (Figure 3).

From the 25 patients with combined resection (anterior and posterior), the condyle was resected in three patients. From the seven patients with posterior resection, the condyle was resected in two patients.

Only minimal changes were seen in comparisons of the intercondylar distances pre- and post-surgery (Figures 4 and 5). The preoperative distance was

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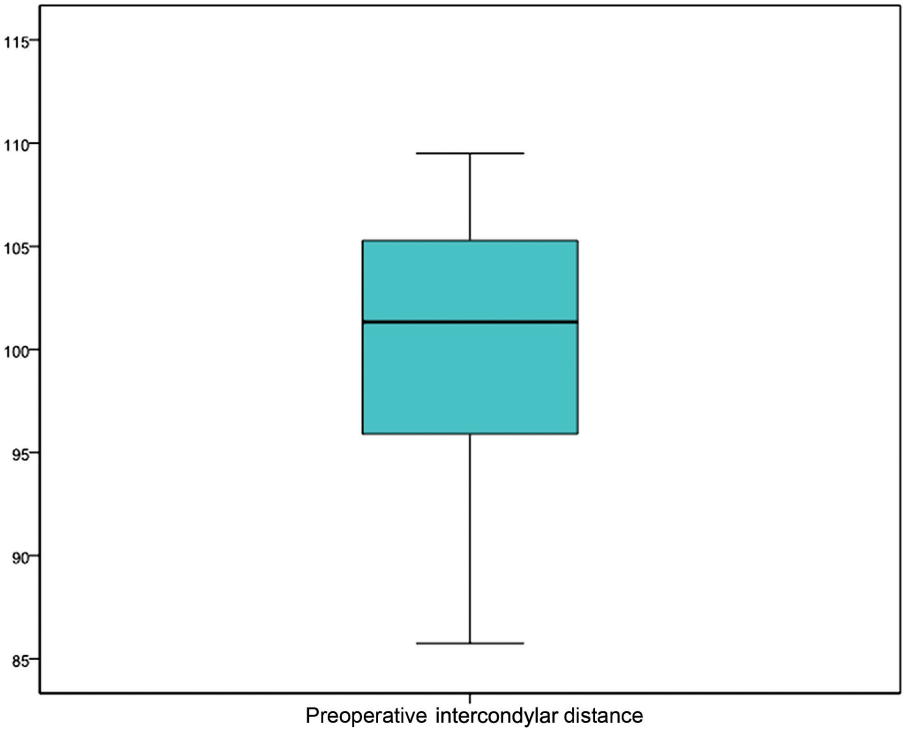

Figure 4: Preoperative absolute intercondylar distance in mm.

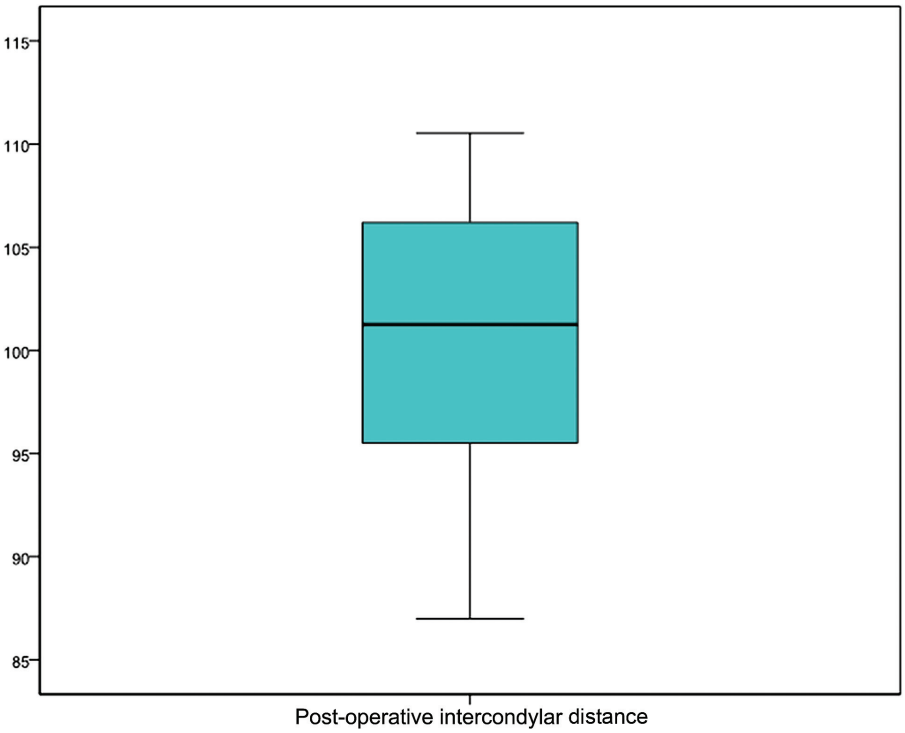

Figure 5: Post-operative absolute intercondylar distance in mm.

between 85.8 and 109.5 mm (median = 100.5 mm) and the post-operative distance was between 87.0 and 110.5 mm (median = 100.6 mm).

In the group of patients with primary reconstruction, the differences pre- and post-surgery seem to be higher in the axial plane (Figure 6).

In the group of patients with secondary reconstruction, greater changes were seen in the group of patients with bone replacement (−0.88 to 7.15 mm) in comparison with those with only reconstruction plate (−3.7 to 3.58 mm) (Figure 7).

In the paired *t*-test, no significant change was found for primary or secondary surgery (Tables 2 and 3).

With regard to age, a difference was seen in the group of patients who received primary bone reconstruction; two children whose bone growth had not completely finished were present in this group (pre-surgery 1: R^2 linear = 0.498; post-surgery 1: R^2 linear = 0.393). In the other group with secondary reconstruction and with only reconstruction plate, there was no correlation (pre-surgery 2: R^2 linear = 0.014; 3: R^2 linear = 0.007; post-surgery 2: R^2 linear = 0.056; 3: R^2 linear = 0.006) (Figures 8 and 9).

Discussion

The geometric accuracy of CBCT and MSCT has not been explicitly validated in this study. However, numerous studies have addressed this topic and showed a high precision for both techniques[4–9]. Repeatability and reproducibility of measurements in MSCT and CBCT datasets has been shown for various indications and in different settings[10–14]. We therefore assume that the data aquired in this study are valid and not biased by means of radiological technique, viewer software or the measurements themselves.

The intercondylar distance varied preoperatively between 85.8 and 109.5 mm (median = 100.6 mm) and post-operatively between 87.0

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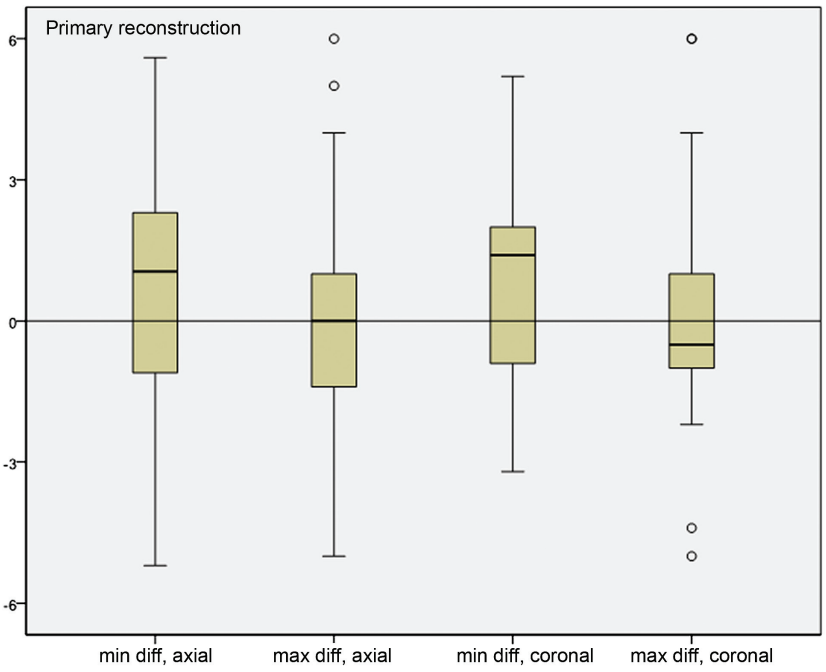

Figure 6: Primary reconstruction (n = 32): comparison of the minimal and maximal pre- to post-surgical differences in distance of the condyles in axial and coronal planes.

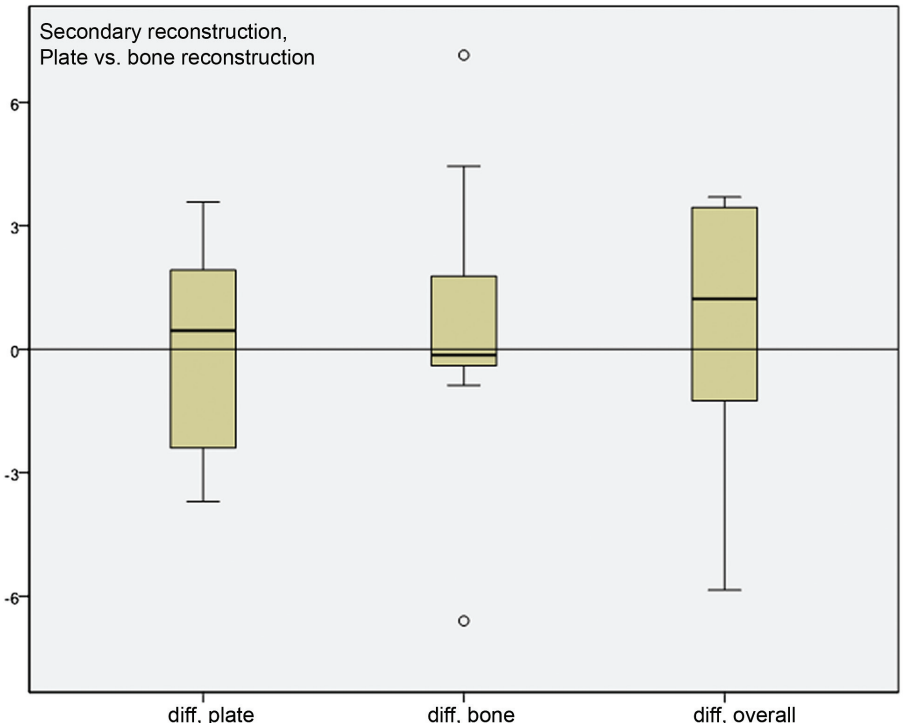

Figure 7: Secondary reconstruction (n = 10): comparison of the differences in distance of the condyles pre- and post-surgery under consideration of the reconstruction type (plate only vs. bony reconstruction vs. overall).

and 110.5 mm (median = 100.5 mm). There was no significant change for only reconstruction plate as well as for bone reconstruction.

There are only a few studies available in regard to intercondylar distance, mainly in healthy patients. Tradowsy demonstrated that the average intercondylar distance in men is 108 mm, whereas that in females is 102 mm[15]. In another study, the distance reported for men was 130.2 mm, whereas for women, it was 123.5 mm[16]. The only study dealing with mandible resection and intercondylar distance was performed by Wilde et al., in which the method of pre-bending reconstruction plates on models was compared with transfer keys to guarantee an exact position[17]. Another possible option—the use of intraoperative computer navigation of the mandible[18–20]—has to our knowledge not yet been applied to control intercondylar distance.

In the present study, a greater difference appeared in bone reconstructions (−0.88 to 7.15 mm) in comparison with only reconstruction plates (−3.7 to 3.58 mm). One reason could be that preoperative bending on models is more exact in regard to reconstruction with bone. On the other hand, the failure rate is higher for reconstruction plates in the long-term and further defect reaches the midline[21,22].

In the group of primary bone reconstruction, positive age dependence was found. This group included two children (a 12-year-old girl and 14-year-old boy). The boy had a 10% shorter intercondylar distance in regard to the median, and the girl had a 14% shorter intercondylar distance. On the other hand, utilizing 3D-photography instead of CT, Kau et al. were able to show that for children with mandible resection who are still growing, increased growing processes are found[23]. More extensive studies regarding mandible resection in children are

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Table 2 Intercondylar distances for reconstructive procedure being part of primary surgery (*n* = 32)

	Average	95% CI	*P* value
Axial min pre–axial min post	0.52	−0.33 to 1.38	0.22
Axial max pre–axial max post	−0.42	−1.37 to 0.54	0.38
Frontal min pre–frontal min post	0.89	−0.05 to 1.84	0.06
Frontal max pre–frontal max post	0.01	−1.04 to 1.05	0.99

Table 3 Intercondylar distances for reconstructive procedure being part of secondary surgery (*n* = 10)

	Average	95% CI	*P* value
Axial min pre–axial min post	0.23	−2.77 to 3.23	0.87
Axial max pre–axial max post	0.14	−2.28 to 2.56	0.90
Frontal min pre–frontal min post	−0.06	−4.06 to 3.94	0.97
Frontal max pre–frontal max post	0.20	−3.54 to 3.94	0.90

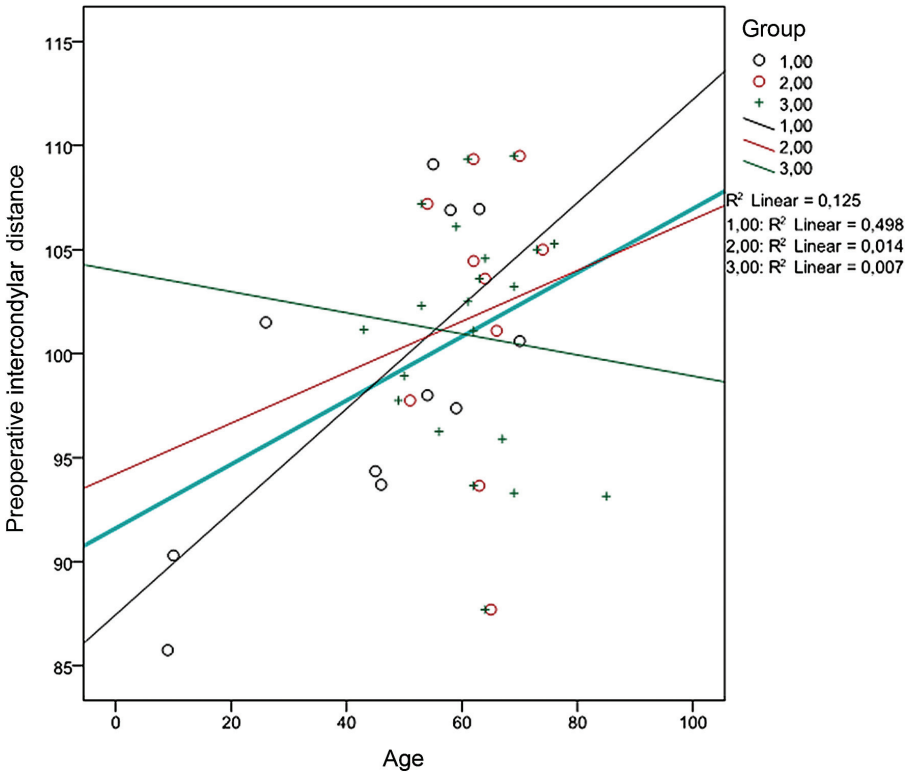

Figure 8: Preoperative intercondylar distance (*n* = 42) (group 1 = primary bone reconstruction; group 2 = secondary bone reconstruction; group 3 = only plate).

necessary, but these are probably difficult to achieve due to the low number of cases usually available and limited utilization of CT in follow-up.

A weakness of this study is that the volume of the bone transplant was not evaluated. This would of great interest in general, but not in the context of the topic addressed in this study. The strength of this study is its relatively high number of patients with pre- and post-operative CT scans for evaluation. To our best knowledge, no other similar study has been performed to date. It has been shown that the intercondylar distance is a parameter that is feasible to evaluate and seems to be stable under the circumstance of adequate mandibular reconstruction regardless of the technique. However, because no failures of mandibular reconstruction were seen in this study, further studies are necessary to validate whether a mismatch between pre- and post-operative intercondylar reconstruction can predict failure of mandibular reconstruction.

Conclusion

In conclusion, there is no significant change in the pre- and post-surgical intercondylar distance. There is no significant difference in reconstruction with bone or with reconstruction plate alone. Further studies should be performed to validate intercondylar distance as a possible predictor for the quality of mandibular reconstruction.

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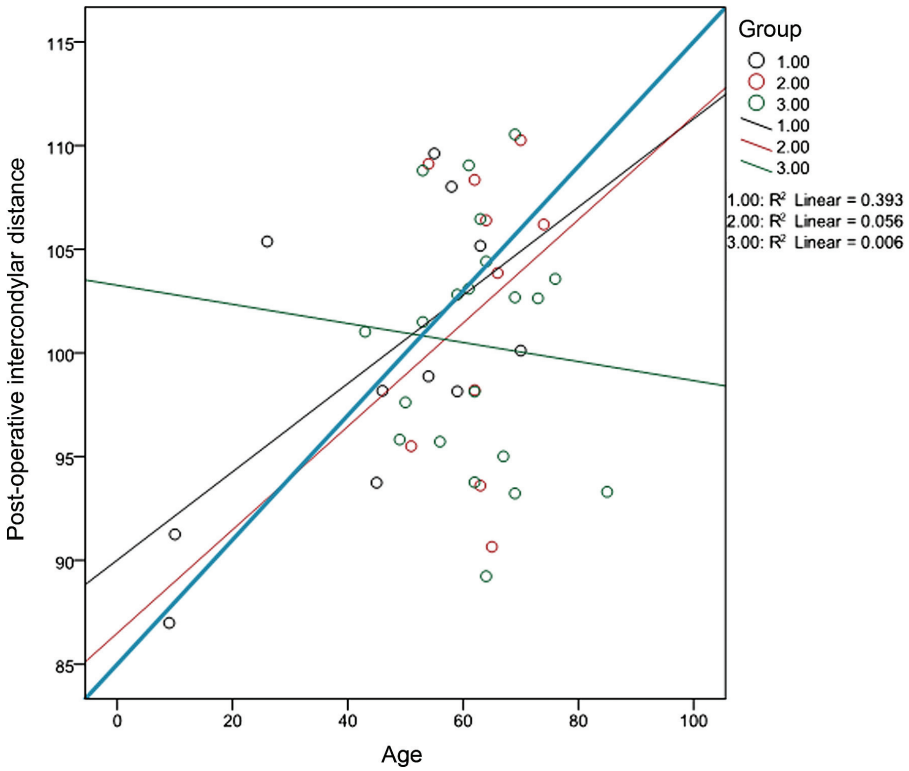

Figure 9: Post-operative intercondylar distance (n = 42) (group 1 = primary bone reconstruction; group 2 = secondary bone reconstruction; group 3 = only plate).

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